1996 Automotive Technology Development Customers' Coordination Meeting

Direct Hydrogen Powered
PEM Fuel Cell Powered
Hybrid
Vehicle Program

Design to Cost Direct Hydrogen PEM Fuel Cell Development

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Objective

AlliedSignal has been a participant in the Partnership for a New Generation Vehicle (PNGV) initiative since the fall of 1994 as a subcontractor to Chrysler through their subsidiary Pentastar Electronics, Inc. The primary role of AlliedSignal in this program is fuel cell stack research and development. The thrust of the AlliedSignal research and development program is to identify novel materials and designs that reduce the projected cost of the PEM fuel cell stack at high production volumes to that of the PNGV goal of $20/kW.

Approach

AlliedSignal's approach has been to treat PEM fuel cell stack cost equal in importance to stack performance. For this reason, AlliedSignal has established a baseline PEM fuel cell stack technology from which our technology will mature that is not based on graphite. This tactic has been central to our success in remaining focused on alternative, low cost materials and designs. AlliedSignal has drawn resources from our automotive, engineered materials, and aerospace sectors to integrate expertise in manufacturing, materials science, polymer chemistry, polymer processing, electrochemistry, catalysis, heat transfer, fluid mechanics, and design into our PEM fuel cell stack research and development team. Out of the box thinking at AlliedSignal has resulted in an evolution to a PEM fuel cell technology that is substantially based on plastics and the low cost manufacturing technologies that avail themselves to plastics.

Accomplishments

The AlliedSignal PEM fuel cell research and development effort, through the integrated use of design to cost concepts, is now focused on stack technology that is substantially based on the use of plastics. The technology evolution that has brought AlliedSignal to this focus is shown in Figure 1. The transition from high cost materials and manufacturing (i.e. graphite) to low cost materials and manufacturing has resulted in a significant reduction in the projected specific cost at high production volumes. Presently, AlliedSignal PEM fuel cell stack technology is projected to have a cost of $50/kW at production levels corresponding to 1 million cars per year. The cost distribution of the key components of the AlliedSignal PEM fuel cell stack is shown in Figure 2. With the implementation of plastic components (primarily bipolar plates) into the fuel cell stack, the membrane electrode assembly (MEA), comprised of the gas diffusion electrode and the ionomer membrane, constitutes the most expensive component of the fuel cell stack.

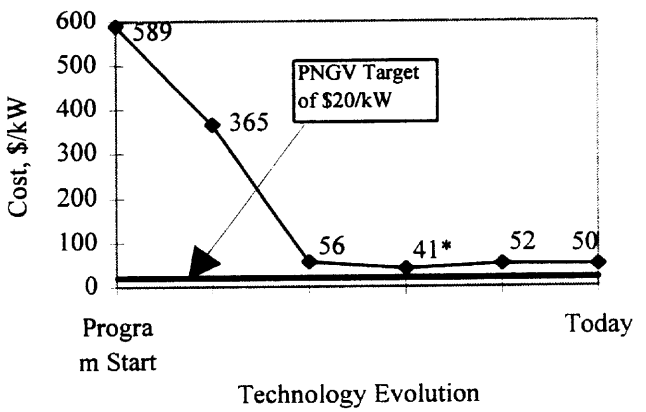
The specific cost reported here is based on a projected membrane cost of $5/square foot[1] and a catalyst loading of 0.25 mg/cm^2 per MEA.

Future Direction

The design to cost efforts described above demonstrate a clear path to advance toward the PNGV goal of $20/kW. Significant technology advancement is still required. While conductive plastics are shown to dramatically reduce cost, their implementation alone is not enough to achieve the PNGV goals. Nor are all of the technical issues with these materials fully resolved. AlliedSignal is committed to refining our conductive plastic technology and will continue R&D efforts in this area.

Advancement is also required in MEA technology. As Figure 2 indicates, the gas diffusion electrode and the membrane constitute a greater fraction of the stack cost than do the bipolar plates. AlliedSignal will have on-going research and development activity in MEA technology that will have as its focus high performance at low cost. As with our stack development activities, cost and performance will be treated as equal in importance.

Figure 1: Stack Technology Evolution



[1] Technology Development Goals for Automotive Fuel Cell Power Systems, Contract #22822402, August 1994

* Represents material selection later found to be unsatisfactory